Improving methane production from lignocellulosic rich waste using biological pretreatment

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INTRODUCTION

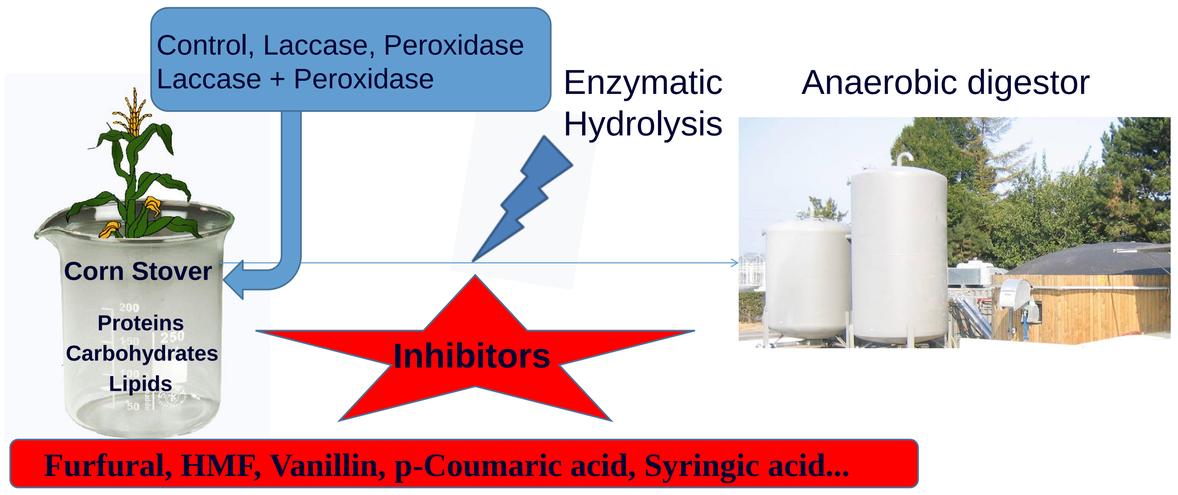
Due to the limiting amount of fossil fuels and its impact on the environment, the need to investigate the potential of **alternative/renewable energy** sources is of importance. Second generation biofuels, like waste streams could form an ideal energy source towards a green future. However, at this moment **hydrolysis** is the limiting process steps and need to be tackled.

Biological pretreatments can be performed with low chemical requirements and under mild environmental conditions while producting low amounts of inhibiting by-products.

AIM

Obtain knowledge of the impact of various enzymatic pretreatments on corn stover degradation, by analyzing the release of inhibiting phenolic compounds and the biomethane production after anaerobic digestion.

MATERIALS AND METHODS



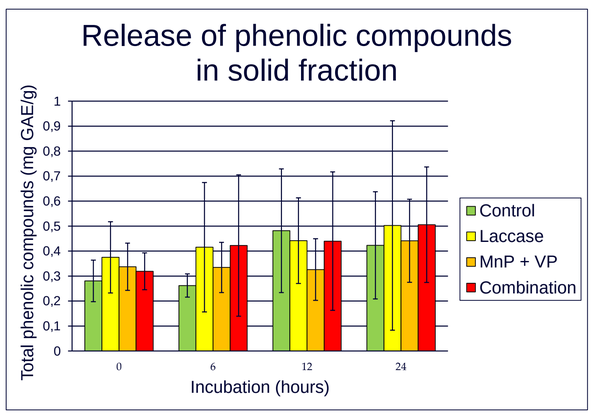
Research questions:

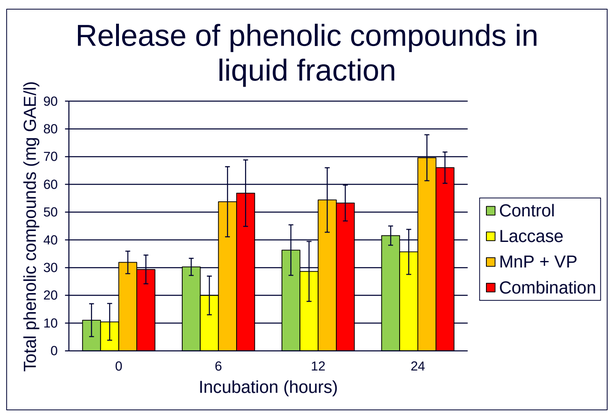
1. What is the impact on release of inhibiting phenolic compounds by folin-ciocalteu method on the solid content and the liquid fraction?
2. What is the impact on biomethane production by BMP analysis?
3. Can a good first order model of the biomethane production be found?

RESULTS AND DISCUSSION

1 *Impact on release of phenolic compounds*

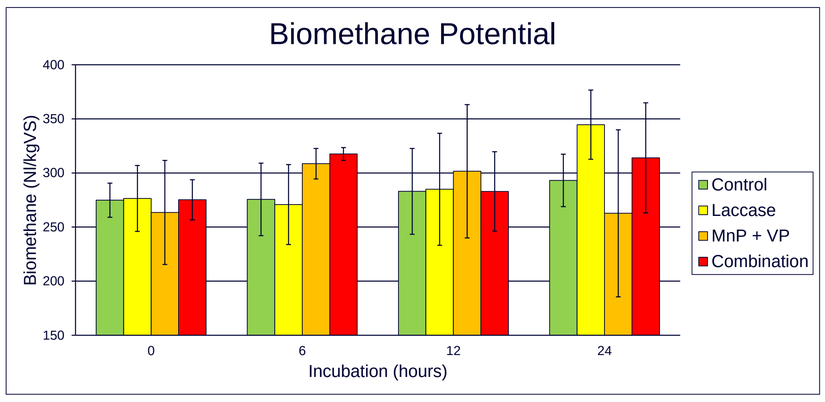
The amount of phenolic compounds extracted from the solid fraction is the same for all pretreatments, but a shift of phenolic compounds to the liquid fraction can be seen in the samples treated with the peroxidase enzymes, or the combination of enzymes. Phenolic compounds are degradation products of the lignin barrier, indicating that these treatments have an effect on the substrate degradation process, making cellulose more available. Laccase however has been known to induce an oxidation reaction, resulting in unstable, reactive phenoxy radicals which can lead to a polymerization reaction. This lowers the total phenolic compounds as measured by the Folin-Ciocalteu method.





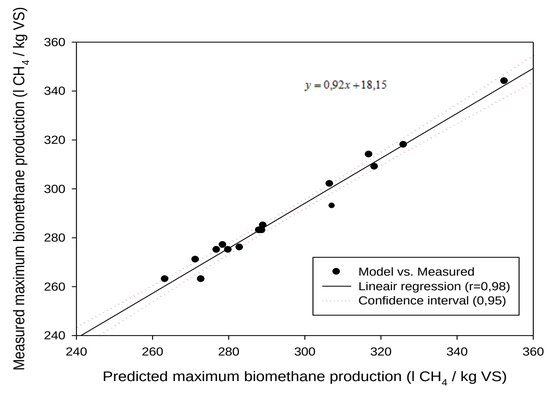
2 *Impact on biomethane production*

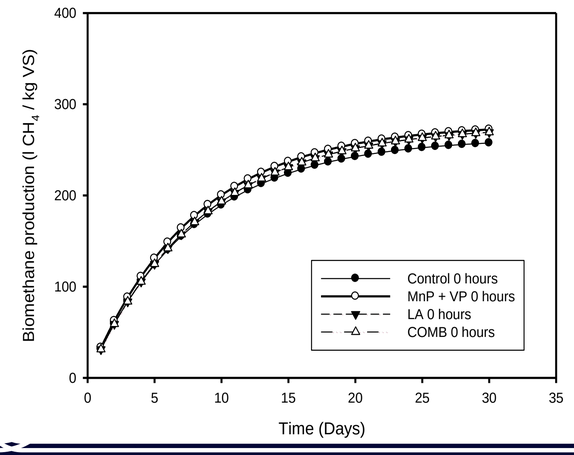
The biomethane production was measured over 30 days and two effects were observed. Firstly the treatments containing peroxidase enzymes had a positive effect on biomethane production after 6 hours of incubation (Peroxidase: +17 %, Combination: +16%). Secondly the treatments containing the laccase enzyme showed a positive effect on biomethane production after 24 hours of pretreatment (Laccase: +25 %, Combination: +14 %).

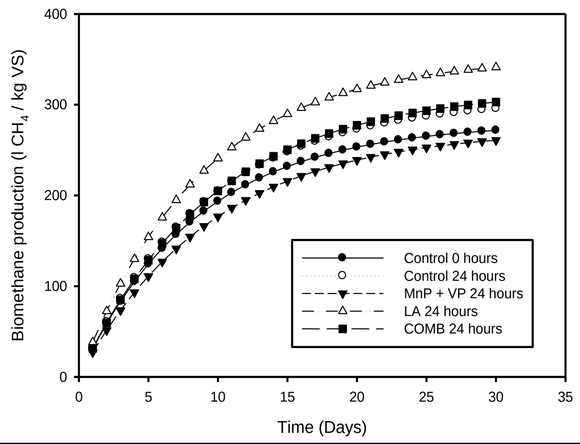


3 *First order modelling of biomethane production*

The biomethane curves were modelled using a first order model: $P = \gamma*(1-e^{(-\mu t)})$ with γ the predicted maximal biomethane value and μ the specific production rate. A good fit was obtained with a minimum Pearson correlation of 0.74, and 50 % of the curves having a Pearson correlation coefficient > 0.90. A differences in specific productions rate was not noticed, showing no significant difference in the hydrolysis rate during the anaerobic digestion. The improvement of 25 % in biomethane potential after the laccase pretreatment is seen in the model prediction, as well as a good correlation between the measured maximum biomethane production and the prediction.







CONCLUSIONS

The effects of different enzymatic pretreatments of corn stover were compared by measuring the degradation products and the biomethane production after anaerobic digestion. Pretreatments with enzymes gave a **higher release** of **phenolic compounds** indicating higher lignin degradation, but inhibition levels were never reached. The degradation of lignin by **laccase** pretreatment led to an increased biomethane production of **25 %**, while **peroxidase** pretreatment gave an increased biomethane production of **17 %. No symbiotic effect** between the laccase and the two peroxidases was noticed. A treatment with both enzyme groups increased biomethane production with 16 % after 6 hours of treatment and 14 % after 24 hours of treatment.

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